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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON 25, D. C.

Letter
Circular
LC924
(Superseding
LC460)

November 1, 1948

TESTS OF RESISTANCE APPARATUS

This letter circular supplements the following Test Fee Schedules:

201.101 Precision Standard Resistors
201.102 Precision Resistance Apparatus
201.207 Resistors above 1 Megohm
201.301 Standard Resistors for Current Measurements
201.312 Measurement Voltage Dividers (Volt Boxes)

Condition of Apparatus. - To be accepted for test and certification, precision standard resistors and resistance apparatus must be of good design, workmanship and material, must have clean contacts, clean and good insulation, and must be in good working condition. If it is evident that the apparatus has been kept in rancid oil, used with excessive test currents or otherwise abused, or has not received proper care, a test will be made only in case it is shown that there is a special need for it. Resistors and resistance apparatus not intended for use in measurements are not ordinarily tested at this Bureau.

Precision Resistance Apparatus. - The following features are considered essential in the best precision resistance apparatus:

(a) Resistance material - The resistance material should have a low temperature coefficient, should not change its resistance with time, and for low-valued coils should have a small thermoelectric power against copper.

(b) Construction - All wire standard resistors and the more important sections of resistance apparatus for use in d-c circuits should be wound on metal supports, preferably in a single layer. Electrical connections to the resistance material should be brazed in all cases in which the total resistance is less than 1000 ohms. The resistance material should be protected against oxidation and other chemical action, and after winding should be annealed or aged by baking.

(c) Adjustments - Precision standard resistors and resistance apparatus should be so adjusted as to give an accuracy of at least 0.1 percent without corrections.

(d) Design - Terminals should be so arranged as to give definite values to the resistances. Provision for dissipating heat should be such that the errors caused by heating under conditions of test or use will not prevent measurements to an accuracy somewhat higher than that desired in the test.

New Apparatus. - Because of the comparatively rapid changes in resistance which take place in new apparatus, it is not advisable to test new or repaired apparatus until at least two months after the resistors have been annealed and adjusted.

Test Current. -Unless otherwise stated, the tests listed are generally made using a direct current of such magnitude as to cause only a negligible heating of the resistance material.

Nature of Test.-- Unless otherwise stated, tests of standard resistors, bridges and rheostats consist in determinations of the resistance of the standards or of the resistance of the elements of the bridges or similar apparatus corresponding to all possible readings. Tests of potentiometers consist in determinations of the ratios of the resistances corresponding to all possible readings.

Standard Resistors for Current Measurements. - Standard resistors used to measure large currents are often heated by the passage of the current to such an extent that their resistance while in use is materially different from that at room temperature. Such resisters when first submitted for test should be tested both with small test current and with full rated current. (Schedule 201.301 (a) and (b) or (c)). The change in resistance between these two conditions, if not excessively large, is a fairly definite property of the standard, and in later tests determinations need be made only with small test current. (Schedule 201.301 (a)). Resistors of very large current capacity are often so constructed that the temperature rise and distribution in them is dependent to a large extent upon the heat generated at the current-terminal contacts and on the cooling effects of the bus-bars to which they may be connected. When this is the case, resistance determinations made in the laboratory even with rated current cease to be of value because the working temperature conditions cannot be duplicated. The best experimental procedure to use in such cases is to place the standard in a temperature-controlled enclosure and measure its resistance with a comparatively low test current when it is heated uniformly to temperatures approximating that at which it will operate in service. (Schedule 201.301 (d) and (e)). From data at two or more elevated temperatures combined with that at room temperature a curve can be plotted from which the resistance at the operating temperature can be read off, provided this temperature is determined by the user with the standard under the actual operating conditions.

Measurement Voltage Dividers (Volt Boxes). - A measurement voltage divider is a tapped resistor used to extend the voltage range of a potentiometer or other voltage-measuring device. Its ratio is defined as the ratio of the total applied voltage to the voltage drop in the tapped section across which the measuring device is connected, no current being withdrawn at the tap point. Both self-heating and humidity effects may cause changes of several hundredths percent in the value of ratio. Measurement voltage dividers should therefore be tested at rated voltage. A further test at 20 percent rated voltage is often desirable because at this voltage any self-heating effect should be negligible. From the two values the extent of the self-heating effect at rated voltage may be determined and an estimate may be made of effects at intermediate voltages. Tests having once been made on a measurement voltage divider at rated voltage and at 20 percent of rated voltage, later tests need be made only at rated voltage since the self-heating effect should not change with time.

Resistors above 1 Megohm. - Standards of high resistance should be made of such materials that their resistances do not change with time. They should be so constructed and treated that the effect of relative humidity is minimized. As the resistance of these resistors usually depends upon the voltage, the voltage to be applied to the resistor during test should be specified.

Shipment. - Unless delivered by special messenger, the apparatus should be carefully packed so as to avoid damage in transit, and should be shipped express prepaid to the National Bureau of Standards, Washington 25, D. C. A letter stating the tests desired should be delivered with the apparatus or mailed at about the time of shipment.

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